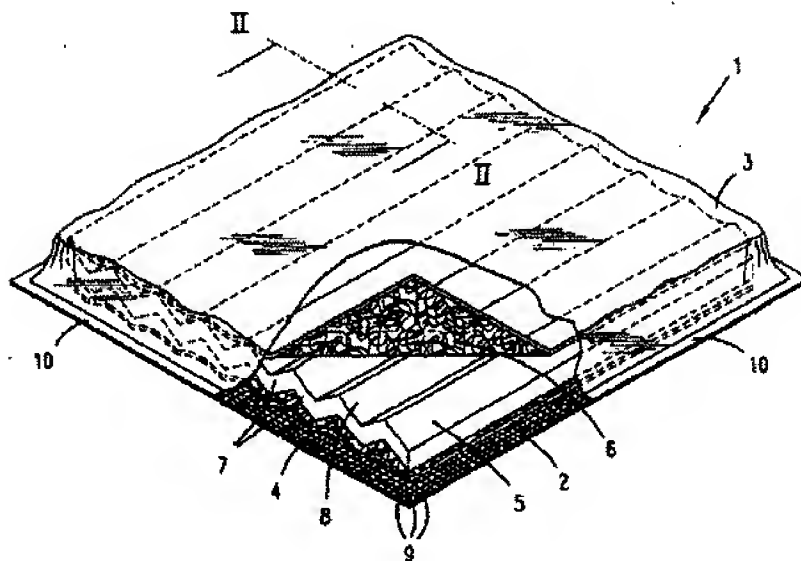


- (12) Laid-open specification
- (10) DE 198 56 377 A1
- (54) Multilayer insulation element
- (57) The invention relates to a multi-layer insulating element (1) with a layer of nonwoven material (4, 6) and a layer of cellular material (5), which are provided in layers arranged one on top of the other. To meet requirements such as high sound absorption or sound insulation and/or high thermal insulation and/or low level of liquid water formation when there are great temperature gradients and/or low weight per unit area and/or good suitability for handling as a fitted element, the invention proposes that the layer of cellular material (5) consists of unevenly, three-dimensionally structured polyimide foam.



Description

The invention relates in the first instance to a multi-layer insulating element with a layer of nonwoven material and a layer of cellular material, which are provided in layers arranged one on top of the other.

Insulating elements of this type are already known in various forms. However, these are not satisfactory in every respect with regard to various requirements, which are generally to be accomplished in combination. Among these requirements are high sound absorption and sound insulation, a high thermal insulation and a low level of liquid water formation when there are great temperature gradients and great atmospheric humidity gradients, if at all possible also combined with comparatively low weights per unit area and good suitability for handling as a fitted element.

The invention is therefore concerned with the technical problems involved in specifying an insulating element of the type in question which is distinguished by meeting one or more of the aforementioned requirements to a high degree of satisfaction.

These technical problems are initially and essentially solved by the subject-matter of Claim 1, based on the idea that the layer of cellular material consists of unevenly, three-dimensionally structured polyimide foam. As a result of this configuration, a layer of the insulating element which is distinguished by low weight with a comparatively large volume is created. This layer of polyimide foam is structured in such a way that, when viewed in the extent of its plane, it extends in a third dimension, i.e. toward the layer of nonwoven material arranged above this layer or away from the layer of nonwoven material arranged below this layer, for example by means of elevations in certain regions.

These may be further formed for example by wave-like or pit-like elevations or formations. In

this respect, a foam-moulded polyimide foam can also be used. The uneven structure of the polyimide foam, formed on an upper side, may also be reproduced in negative on the underside, so that according to the invention both surfaces are unevenly, three-dimensionally structured, to increase the overall surface area of the layer of cellular material. Furthermore, the invention also relates to a multi-layer insulating element with two layers of cellular material which are provided in layers arranged one on top of the other, the invention being based here on the idea that a layer of cellular material consists of unevenly, three-dimensionally structured polyimide foam. Irrespective of the layered structure, which is a matter of choice, that is a layer of nonwoven material with a layer of cellular material or two layers of cellular material, in a preferred configuration of the subject-matter of the invention it is provided that the layer of cellular material consists of a cut-to-size foam. It is particularly preferred in this respect that the layer of cellular material runs along in a zigzag form, the path it follows extending in the plane of the layer of cellular material. Accordingly, the elevations formed by the zigzag form extend in the direction of the layer arranged above it and/or below it. As a result, the layer (layer of nonwoven material or further layer of cellular material) arranged above and/or below the layer of cellular material formed according to the invention is kept at a distance from the layer of polyimide foam, cavities approximately V-shaped in cross section being formed in the interstices of the zigzag form. It proves to be particularly advantageous in this respect for a desired sound absorption behaviour to be set by means of the thickness and/or the angled path in relation to the perpendicular of the zigzag links. As a consequence of this configuration, the sound absorption behaviour can be pre-set during the production of the layer of cellular material

according to the invention by choosing the material thickness and/or the path followed by the zigzag structure. In a further configuration of the subject-matter of the invention, it is provided that the layer
5 of cellular material is covered on the upper side and underside by a layer of nonwoven material. This may in each case be a needled, condensed or mechanically compacted nonwoven. Furthermore, melofil fibres may also be used here in a proportion of 10-70%, preferably
10 50%. It is also conceivable to form the upper layer of nonwoven material, preferably facing the noise source, as a melt-blown nonwoven and to form the lower layer as a thermally bonded volume nonwoven. Furthermore, there is also the possibility of using a blend of melamine
15 fibres and basofil fibres for producing a three-dimensional framework. In addition, with an arrangement of at least two layers of cellular material lying one on top of the other, there is the possibility of forming each layer of cellular material from
20 polyimide, the unevenly, three-dimensionally structured, preferably zigzag-structured layer of polyimide foam being covered on the upper side and underside with an even layer of polyimide foam that is relatively thin in relation to the layer of structured
25 cellular material. In addition, two layers of cellular material may also be provided, with a layer of nonwoven material provided between them. Preferred in this respect is a configuration in which both layers of cellular material are designed in a way corresponding
30 to the configurations described above in an unevenly, three-dimensionally structured manner as layers of polyimide foam and the interposed layer of nonwoven material is a melt-blown nonwoven. The layers of the insulating element are, furthermore, sheathed by a
35 film. In particular, this sheathing film comprises two layers of film, which are further preferred to be outer layers. These layers of film sheath the layers of insulation arranged one on top of the other to form a compact, multi-layer insulating element. The layers of

film may also be additionally provided as intermediate layers. It is further preferred for the outer films to be edge-welded, but all or some of the layers of nonwoven and/or cellular material may be integrated
5 into the weld, for instance by a layer of nonwoven and/or cellular material edge-compressed to virtually nothing. Such edge compression may also be used for shaping the component. Fastening elements may also be integrated into such a weld. The joining together of
10 the outer films is suitably provided in this case by the complete composite structure being held together just by the edge-welded films and possibly layers of nonwoven and/or cellular material. No adhesive bonding, lamination or the like of individual layers is
15 required and is preferably also not provided. The layers are simply laid one on top of the other - at least outside the edge region. This produces as it were a cushion with a sheath formed by the outer films. Partial compressed portions, brought about by welding
20 operations, in particular in the edge region, can play a part in accommodating fastening elements and/or reinforcements of the component. The plurality of layers (layers of nonwoven and/or cellular material) lead to a kind of swollen filling. It is also of
25 significance for the subject-matter that the formation of liquid water in the component is reduced. The films used, both the outer films and possibly also intermediate films, have different water permeability, it being preferred for water-vapour-permeable membrane
30 films to be used. Preferably used are also films which have direction-active water vapour permeabilities. Films which have moisture-dependent and/or temperature-dependent water vapour permeabilities may also be used. Furthermore, these films may also be fibre-reinforced,
35 it being further preferred in this respect for these fibres to be provided on the inner side of the film.

The invention is further explained in more detail below with reference to the attached drawing, which however merely represents one exemplary

embodiment and in which:

Figure 1 shows a partially sectioned perspective representation of a multi-layer insulating element according to the invention;

5 Figure 2 shows a greatly enlarged representation of the section along the line II-II in Figure 1.

With reference to Figure 1, an insulating element 1 which comprises a lower outer film 2 and an upper outer film 3 and three middle layers 4, 5 and 6 is represented.

The layers of nonwoven material 4 and 6, of an even form, are formed from identical or non-identical nonwoven material. The fibres of the nonwoven material consist of a polymer, such as for example PPS or a blend of PPS and copolyester and other organic or inorganic fibres, the weights per unit area of the layers of nonwoven material 4 and 6 lying between 50 and 800 g/m². Moreover, the upper layer of nonwoven material 6, preferably facing a noise source, may consist of a melt-blown nonwoven and the lower layer of nonwoven material 4 may consist of a thermally bonded volume nonwoven.

The fibres are thermoplastic and inherently flame-retardant. The granules from which the nonwoven fibres are obtained have a specific melt viscosity. The nonwovens are also resistant to hydrolysis. Moreover, they are acoustically absorbent and insulating. In addition, they have a thermally insulating effect.

The middle layer 5 is designed as a layer of cellular material, in particular as a layer of polyimide foam which, as can be seen in particular from the sectional representation in Figure 2, is unevenly, three-dimensionally structured. In fact, the design is chosen such that the layer of cellular material runs along in a zigzag form in the extent of its plane. The choice of a polyimide foam creates a very lightweight middle layer with a comparatively large volume for the

formation of the insulating element 1.

The layer of cellular material consists of a cut-to-size polyimide foam, the thickness and/or angled path in relation to the perpendicular of the zigzag links 7 allowing a desired sound absorption behaviour to be set. In the exemplary embodiment shown, a material thickness d of approximately 8 mm has been chosen, with a total height h of the zigzag-shaped layer of cellular material 5 of approximately 24 mm. Consequently, a ratio of material thickness d to layer height h of approximately 1 : 3 has been set.

Furthermore, an angle α of the links 7 in relation to the perpendicular of 45-60°, for example 55°, is chosen.

The thicknesses of the layers of nonwoven material 4 and 6 are - in the non-compressed state - approximately one third to one tenth of the thickness of the middle layer (layer of cellular material 5). The thicknesses of the layers of nonwoven material 4 and 6, seen in absolute terms, lie in the range from 0.5 to 2 mm.

The arrangement of the individual layers 4 to 6 one on top of the other has the effect of producing V-shaped cavities 8, covered by the respectively assigned layer of nonwoven material 4 or 6, in the region of the interstices formed by the zigzag form of the middle layer of cellular material 5. Furthermore, this may have the result that each layer of nonwoven material 4, 6 has a slightly corrugated structure in the extent of its plane, according to the cross-sectional representation in Figure 2; it is accordingly not stretched taut over the middle layer of cellular material 5.

The layers of film 2 and 3 are fibre-reinforced films of very small thickness. The thickness lies between 10 and 15 μm , preferably around 20 μm . The density lies around approximately 0.9 to 1.4 g/cm^3 . The films are likewise thermoplastic and resistant to hydrolysis. In particular, they also have water-vapour

permeabilities matching one another.

In terms of material, inherently flame-retardant polymers may be concerned. As fibres, glass fibres, but also melamine resin fibres, may be laminated on for example. In the exemplary embodiment represented, only the lower outer layer of film 2 is fibre-reinforced, the fibres 9 being provided on the inner side of this film 2. The fibres 9 are indicated in Figure 1 by a grid on the lower outer layer of film 2. In the cross-sectional representation according to Figure 2, the criss-cross arrangement of the fibres 9 is represented on an exaggerated scale.

It is preferred for the fibres 9 to be provided only on one side of the film. The grid lies between approximately 1 and 5 mm. Fibres respectively running transversely in relation to one another are provided.

The outer layers of film 2, 3 are edge-welded, it also being conceivable to take the exemplary embodiment represented a stage further and integrate all or some of the layers of nonwoven and/or cellular material 4 to 6 into the weld 10, this being accomplished for instance by an edge compression of the layers of nonwoven and/or cellular material 4 to 6 going to virtually nothing.

The edge compression may be used for shaping the component. Fastening elements may also be integrated into such a weld 10.

The complete composite structure is held together just by the edge-bonded or edge-welded films 2, 3, possibly with the layers of nonwoven and/or cellular material 4 to 6 being incorporated.

The layers 4 to 6 are simply laid one on top of the other - at least outside the edge region. This produces as it were a cushion with a sheath formed by the outer films 2, 3.

All features disclosed are essential for the invention. The full content of the disclosure of the associated/attached priority documents (copy of the prior application) is hereby incorporated in the

disclosure of the application, also for the purpose of including features of these documents in claims of the present application.

CLAIMS

1. Multi-layer insulating element (1) with a layer of nonwoven material (4, 6) and a layer of cellular material (5), which are provided in layers arranged one on top of the other, characterized in that the layer of cellular material (5) consists of unevenly, three-dimensionally structured polyimide foam.
2. Multi-layer insulating element (1) with two layers of cellular material which are provided in layers arranged one on top of the other, characterized in that a layer of cellular material (5) consists of unevenly, three-dimensionally structured polyimide foam.
3. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that the layer of cellular material (5) consists of a cut-to-size foam.
4. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that the layer of cellular material runs along in a zigzag form.
5. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that a desired sound absorption behaviour is set by means of the thickness (d) and/or the angled path (angle alpha) in relation to the perpendicular of the zigzag links (7).
6. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that the layer of cellular material (5) is covered on the upper side and underside by a layer of nonwoven material (4, 6).
7. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that two layers of cellular material (5) are provided and a layer of nonwoven material is provided between the layers of cellular material (5).

8. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that the layers (4 to 6) of the insulating element (1) are sheathed by a film.

5 9. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that the sheathing film comprises two layers of film (2, 3).

10 10. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that the layers of film (2, 3) are outer layers.

15 11. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that the outer layers of film (2, 3) are edge-welded and in that the complete composite structure is held together as a result.

20 12. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that the layers of film (2, 3) are water-vapour-permeable membrane films.

25 13. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that one film (2, 3) is fibre-reinforced.

14. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that the fibres (9) are provided on the inside of the film (2, 3).

30 15. Insulating element according to one or more of the preceding claims or in particular according thereto, characterized in that the layers of film (2, 3) are intermediate layers.

